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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H01Q 3/32 — A1

(11) International Publication Number: WO 96/37922

(43) International Publication Date: 28 November 1996 (28.11.96)

(21) International Application Number: PCT/SE96/00678

(22) International Filing Date: 24 May 1996 (24.05.96)

(30) Priority Data:
9501955-0 24 May 1995 (24.05.95) SE

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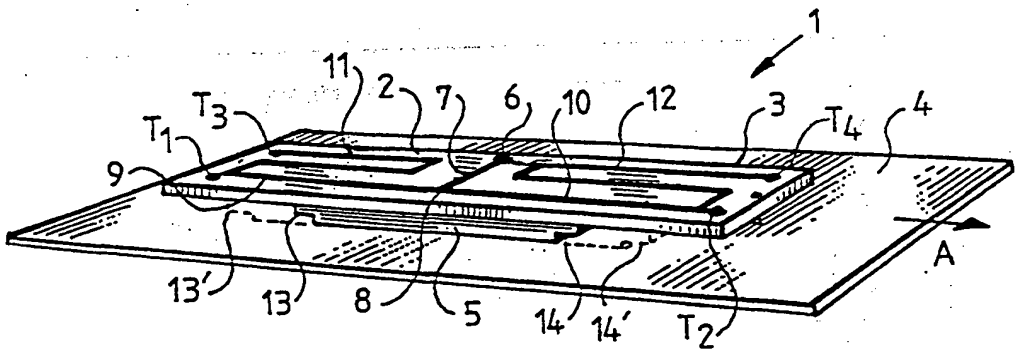
(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: DEVICE FOR ADJUSTING THE BEAM DIRECTION OF AN ANTENNA, AND FEED LINE STRUCTURE THEREFOR



(57) Abstract

A feed line structure (1), especially integrated with a stationary array of antenna elements so as to enable adjustment of the direction of the beam radiated from the array. The feed line structure comprises a feed conductor line pattern (3) disposed on a fixed carrier plate (2) at a distance from and in parallel to a fixed ground plate (4), and a movable dielectric plate (5) located therebetween. The feed line pattern (3) is elongated in the same direction (A) as the movement direction of the dielectric plate (5). The propagation velocity of the signal components is reduced by the dielectric plate (5), whereby a controlled phase difference between the various signal components is obtained.

DEVICE FOR ADJUSTING THE BEAM DIRECTION OF AN ANTENNA, AND FEED LINE STRUCTURE THEREFOR

The present invention concerns a device for adjusting the beam direction of a beam radiated from a stationary array of antenna elements, wherein at least two antenna element feed points are coupled to a common signal source via a feed line structure having a source connection terminal to be connected to said source and at least two feed connection terminals to be connected to said antenna element feed points, said feed line structure comprising a feed conductor line pattern disposed in a fixed planar arrangement, e.g. on a carrier plate, at a distance from and in parallel to a fixed ground plate, and a movable dielectric body located therebetween, said movable dielectric body being displaceable in parallel to said feed conductor line pattern and said ground plate so as to change the exciting phase of a signal component reaching one of said feed connection terminals. The invention also concerns a feed line structure for use in an antenna or any other device requiring a controlled adjustment of the phase difference between at least two signal components derived from a radio frequency signal generated by a common source.

A device of the kind referred to above is previously known from JP, A, 63296402. A number of triangular dielectric bodies are movable in two perpendicular directions, in each case transversely to a conductor line segment so as to enable a controlled delay of the corresponding signal component. The delay is substantially proportional to the surface portion of the triangle being in registry with the associated conductor line segment. In this way, the beam can be adjusted in two mutually perpendicular directions.

However, each triangular body has relatively small dimensions in relation to the length of each conductor line leading to a feed connection terminal. Therefore, the adjustment possibilities are rather limited. Furthermore, in case such triangular bodies with larger dimensions were to be used, the

connection terminals are located at opposite end portions of the pattern. The dielectric plate then extends in a region also covering the central portion of the feed line pattern and it will normally have a relatively large area corresponding to at least half of the surface area of the carrier plate (or the outer contour of the feed line pattern).

In a preferred embodiment, the dielectric plate is substantially rectangular, and the feed conductor line pattern is meander-shaped. Moreover, because of the elongated structure of the meander-shaped pattern, the longitudinal feed line segments constitute a major part of the total length of the feed line segments in the feed conductor line pattern.

In principle, there could be only two feed connection terminals, one at each end of a straight conductor line. However, most preferably, the feed conductor line pattern includes several meander-shaped portions with loops being branched off from each longitudinal feed line segment and including at least two further longitudinal feed line segments.

With such a meander-shaped configuration, it is possible to keep a predetermined relation between the phase angles of the various signal components, irrespective of the particular position of the dielectric plate.

Preferably, the dielectric plate is displaceable by means of a mechanical actuator coupled to a manually operable control means, e.g., a control knob on a rotatable axis coupled via a gear mechanism to a longitudinally guided rack, which is secured to the dielectric plate.

Further details and modifications of the feed line structure are stated in the dependent claims and will appear from the detailed description below, reference being made to the drawings.

slightly lower in those portions of the conductive line segments lying above the plate 5, due to the dielectric material between the conductive line and the ground plate.

When the plate 5 is displaced in the main direction A, e.g., to an end position corresponding to the dotted lines 14', the signal components propagating along the conductor line segments 10 and 12 will be delayed, more so at the feed connection terminal T_4 than at the feed connection terminal T_2, whereas the signal components propagating along the conductor line segments 9 and 11 will run slightly ahead, more so at the feed connection terminal T_3 than at the feed connection terminal T_1. On the other hand, when the plate 5 is moved in the opposite direction, to the end position indicated by the dotted lines 13', the reverse conditions will prevail, i.e. the signal components propagating along the conductor line segments 9 and 11 will be delayed, whereas the signal components propagating along the conductor line segments 10 and 12 will run ahead.

Because of the geometrical configuration, the phase angle differences between the signal components at feed connection terminals T_4, T_2, T_1 and T_3 will always be the same, irrespective of the particular position of the dielectric plate 5. In particular, assume that the end position 13' corresponds to an exactly horizontal direction of the composit beam radiated from four antenna elements connected to the terminals T_1 through T_4. When the plate 5 is displaced a certain increment in the direction A, the signal components at the four terminals will be delayed, e.g., with phase angle shifts of 15°, 5°, -5° and -15° (in the order T_4, T_2, T_1 and T_3). Then, upon a further incremental displacement, the angle shift will be, e.g., 30°, 10°, -10° and -30°. So, the phase angle differences between adjacent terminals will always be the same. Accordingly, the composit beam from the four antenna elements will always have a wave front in the form of a straight line. With increasing angular phase differences, the inclination of this wave front line will increase, and the beam will be gradually tilted downwards.

Clearly, it is a great advantage that the uniform phase angle difference between the various feed connection terminals will be maintained in the course of a simple linear movement of the dielectric plate 5.

Of course, it is possible to modify the configuration of the feed line structure with meander-shaped loops. In figure 2, a number of such modified embodiments are shown.

In the first example (at the top of figure 2) there are three separate feed line structures, of which the structures 1a and 1b each correspond essentially to the embodiment shown in figure 1, whereas the central feed line structure 20 merely serves to feed the outer structures 1a and 1b with their respective terminals T_1 through T_4 and T_5 through T_8.

The central darker areas depict the respective dielectric plates 5, and these three plates are mechanically coupled together so as to be moved in synchronism. In this way, eight antenna elements can be fed with eight different signal components derived from a common source signal.

The next two examples are slightly modified embodiments with outer and central structures 1'a, 1'b, 20' and 1''a, 1''b and 20'', respectively. In the latter example, the dielectric plates are not as wide as the carrier plate.

The variation possibilities are enormous, and at the bottom of figure 2 there are two further examples of feed line structures each feeding eight feed connection terminals T_1 through T_8 with a single feed line structure 21 and 21', respectively.

Figures 3 and 4 serve to illustrate a mechanical actuator, by means of which the dielectric plate can be displaced by manual control. The feed line structure appears from figure 3 with a modified feed conductor line pattern 31, and from figure 4 with the carrier plate 32 (on which the feed conductor line pattern

CLAIMS

1. A device for adjusting the beam direction of a beam radiated from a stationary array of antenna elements, wherein at least two antenna element feed points are coupled to a common signal source via a feed line structure (1) having a source connection terminal (6) to be connected to said source and at least two feed connection terminals (T_1, T_2, T_3, T_4) to be connected to said antenna element feed points, said feed line structure comprising a feed conductor line pattern (3) disposed in a fixed planar arrangement (2) at a distance from and in parallel to a fixed ground plate (4), and a movable dielectric body (5) located therebetween, said movable dielectric body being displaceable in parallel to said feed conductor line pattern and said ground plate so as to change the exciting phase of a signal component reaching one of said feed connection terminals, c h a r a c t e r i z e d i n that

- said feed line pattern (3) is elongated in a main direction (A),
- said feed line pattern (3) includes longitudinal feed line segments extending in parallel to said main direction (A) towards each one of said feed connection terminals (T_1, T_2, T_3, T_4),
- said dielectric body is formed substantially as a dielectric plate (5), which is displaceable in said main direction (A) between two end positions (13', 14'), and
- said dielectric plate (5) is dimensioned and located so as to extend, in any position between and including said end positions, in a region covering supplementary portions of said longitudinal feed line segments (9, 10, 11, 12), said supplementary portions effecting a controlled propagation velocity reduction of the corresponding signal components before they reach the respective feed connection terminals (T_1, T_2, T_3, T_4).

6. A device as defined in claim 5, c h a r a c t e r i z e d i n that said mechanical actuator comprises a longitudinally guided rack (35) meshing with a gear mechanism (36, 37) coupled to a rotatable axis (38) with a control knob (39).

7. A device as defined in any one of claims 1 through 6, c h a r a c t e r i z e d i n that the device comprises at least one further feed line structure (1b) of the same kind and having a displaceable dielectric plate, which is displaceable in synchronism with the dielectric plate of the first mentioned feed line structure (1a).

8. A device as defined in claim 7, c h a r a c t e r i z e d i n that two similar feed line structures (1a, 1b) are connected to said common signal source (6) via a third feed line structure (20) of a similar kind.

9. A device as defined in any one of claims 1-8, c h a r a c t e r i z e d i n that opposite end portions (13, 14) of said dielectric plate (5) are provided with step-like recesses dimensioned so as to minimize signal reflexion in the corresponding portions of the feed line structure.

10. A feed line structure (1) for adjusting the phase difference between at least two signal components derived from a radio frequency signal generated by a source, comprising a source connection terminal (6) and at least two feed connection terminals ((T_1, T_2, T_3, T_4), and a feed conductor line pattern (3) disposed in a fixed planar arrangement (2) at a distance from and in parallel to a fixed ground plate (4), and a movable dielectric body (5) located therebetween, said movable dielectric body being displaceable in parallel to said feed conductor line pattern and said ground plate so as to change the exciting phase of a signal component reaching one of said feed connection terminals, c h a r a c t e r i z e d i n that

- said feed line pattern (3) is elongated in a main direction (A),

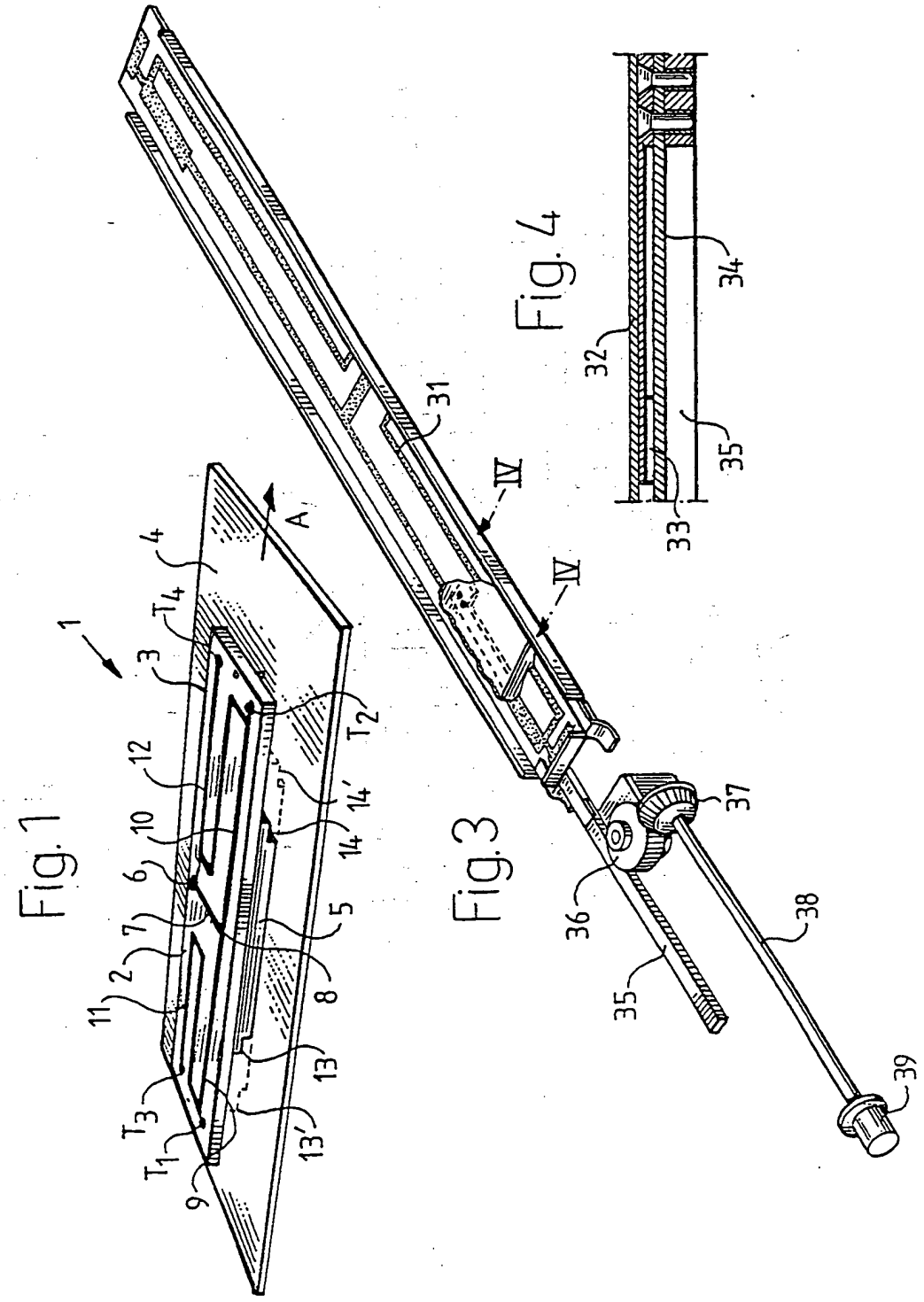


Fig. 1

Fig. 3

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
[redacted]/SE 96/00678

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H01Q 3/32
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Patent Abstracts of Japan,, abstract of JP, A, 62-196903 (MATSUSHITA ELECTRIC WORKS LTD), 31 August 1987 (31.08.87), see the whole document --	1-10
A	Patent Abstracts of Japan,, abstract of JP, A, 63-296402 (MITSUBISHI ELECTRIC CORP), 2 December 1988 (02.12.88), see the whole document --	1-10
A	DE 2947987 A1 (SIEMENS AG), 3 Sept 1981 (03.09.81), page 3, line 27 - page 5, line 23, figure 1/1 --	1-10

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 August 1996	20 -08- 1996
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Karin Säfsten Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information [redacted]ent family members

31/07/96

International application No.

[redacted]SE 96/00678

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A1- 2947987	03/09/81	NONE	
EP-A2- 0618639	05/10/94	NONE	